

SCH 3U1 Assorted Review Questions

1. The following 3 values for the density of water were determined by experiment:

0.99 g/mL, 1.04 g/mL, & 0.94 g/mL. These values are accurate but not precise (**true** or false)

2. How many significant digits are in a) 200 152 ..**6**... 1.0040 x 10⁶**5**.... 0.0048**2**.... 7.0**2**...

3. 18.987 g / 3.06 =**6.20**..... which has**3**..... significant digits

4. What is an example of a **physical property** of matter **density, melting point, boiling pt, colour**

5. What is an example of a **chemical property** of matter **it oxidizes, it burns, reacts with acids**

6. What is an example of a **physical change** **melting, boiling, freezing, dissolving**

7. What is an example of a **chemical change** **burning, oxidation, dble displacement, decomp**

8. What is an example of a quantitative property of matter **density = 4.25 g/mL, MP = 65° C**

9. A group of students collected the following data about a piece of aluminum foil

length = 10.0 cm, width = 7.5 cm, mass = 7.091 g, density = 2.70 g/cm³

What is the thickness of the foil ?**0.035 cm** Which measurement determines its precision ? **width (3 sf)**

$V = m/D = 7.091\text{g}/2.70\text{g/cm}^3 = 2.63\text{ cm}^3$ $Th = 2.63\text{g/cm}^3/(10.0 * 7.5\text{cm}^2) = 0.035\text{ cm}$

10. If a **mixture** has only **one phase** it is said to be **homogeneous** **2 phases ? heterogeneous**

11. Air is classified as a **mixture** because its composition is **variable**

12. Isotopes of the elements contain different numbers of **neutrons** but the same # of **protons & electrons**

13. An **alpha particle** contains **2** protons & **2** neutrons and weighs **4 u**, symbol = **α**.

14. the nucleus $^{209}_{82}\text{Pb}$ emits an alpha particle. Write this nuclear reaction eq'n: $^{209}_{82}\text{Pb} \rightarrow ^4_2\text{He} + ^{205}_{80}\text{Hg}$

15. When an isotope emits a **beta particle** the atomic# of the substance **increases by 1** & the at mass **stays the same**

16. the nucleus $^{209}_{82}\text{Pb}$ emits a beta particle. Write this nuclear reaction eq'n: $^{209}_{82}\text{Pb} \rightarrow ^0_{-1}\text{e} + ^{209}_{83}\text{Bi}$

17. A 100 g sample of a radioactive substance decayed to 3.125 g in 300 days. What is the **1/2 life** of this sub? **60 days**

18. The isotope cobalt-60 ($^{60}_{27}\text{Co}$) has **27** protons & **33** neutrons in its nucleus with **27** electrons around it

19. The isotopic ion $^{56}_{25}\text{Mn}^{2+}$ has **25** protons & **31** neutrons in its nucleus with **23** electrons around it.

The electron configuration for these electrons would be **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^0 3d^5$**

20. Write the e⁻ configuration for phosphorus **$1s^2 2s^2 2p^6 3s^2 3p^3$**

21. Write the e⁻ configuration for copper **$1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$**

22. Group VIA elements have **6** valence electrons, group III elements ? **3**

23. If arsenic acid is H₃AsO₄, what is the formula of calcium arsenate.. **Ca₃(AsO₄)₂**....

24. What is the chemical formula for a) perchloric acid ...**HClO₄**.. b) mercuric nitrate ..**Hg(NO₃)₂**.. c) oxygen gas **O₂**...

d) iron(III) sulfate **Fe₂(SO₄)₃** e) dinitrogen tetroxide **N₂O₄** f) ammonia gas **NH₃** g) magnesium phosphate **Mg₃(PO₄)₂**

25. Write the formula of the hydrated salt ; dialuminum hexachloride octahydrate **Al₂Cl₆·8H₂O**

26.. Potassium chromate (**K₂CrO₄**) is **26.8% by mass** chromium

27. Determine the **empirical**(simplest) **formula** of an organic compound that was 75% Carbon & 25% Hydrogen**CH₄**...

$C = 75\%/12u = 6.2$ $H = 25\%/1u = 25$ * $H/C \text{ ratio} = 25/6.25 = 4 : 1$

28. A compound is 52.2 % C, 13.0 % H and 34.8 % O by mass. Its vapour has a density of 2.05 g/L at STP. What is the structural formula for the comp'd?

$C = 52.2\%/12u = 4.35$ $H/C \text{ ratio} = 13/4.35 = 3 : 1$ $1 \text{ mol} = 22.4 \text{ L} = 46 \text{ g (from density)}$

$H = 13\%/1u = 13$ $H/O \text{ ratio} = 13/2.175 = 6 : 1$

$O = 34.8\%/16u = 2.175$ **simplest form = C₂H₆O (fm = 46 g)**

so simplest formula = formula \rightarrow C₂H₆O

29. The amount of product that is predicted is called the **Theoretical** yield, the actual amount obtained is **actual yield**

30. If you separated a 62 g mixture of sand/salt and recovered 60 g, what was your % yield ?**96.8 %**....

31. What is the name given to a homogeneous mixture of 2 or more metals ...**an alloy**....

32. Write (aq) beside the soluble substances and (s) beside the insoluble substances

(NH₄)₂SO₄ **aq**.. PbCl₂ (**s**). Ba(OH)₂ (**s**) AgC₂H₃O₂..**aq**. Ca₃(PO₄)₂..**(s)** HgClO₄..**aq**.. K₂CO₃..**aq**.. Cu(NO₃)₂..**aq**.

33. Compounds which exhibit colour are generally associated with the...**transition metal**.... elements
34. A solution that is blue probably contains the**copper**..... ion, green ??**nickel ion**...
35. A flame that is pinkish/purple in colour probably has the **potassium**..ion in it. yellow-orange ?? **sodium ion**.
36. As one proceeds from the left to the **right** in the PT the atomic **size**..**decreases**.... **down??****increases**....
from the left to the **right** the **Ionization Energy**.....**increases**.... **down a family** ??**decreases**.....
37. Relative **electronegativity**....**decreases**.. down a family and.....**increases**.... across a period
38. A molecule that has 120° bond angles has a **trigonal planar** (**bent with 1 lone pair**) shape
39. The boron trifluoride molecule has a**trigonal planar**.... shape
40. Carbon tetrachloride has a **tetrahedral**..shape with ..**polar**.. bonds yet the molecule is **not polar**...
41. A molecule of CN^- has how many lone pairs of electrons ? ...**2** :C::N: $^-$.
42. Molecules with bond angles of 109° can have **tetrahedral** or **trigonal pyramid**(**1 LP**) or **bent** (**2 LP**) shapes
43. **_water (bent)** , **ammonia (pyramid)** is an example of a polar molecule.
44. The bonds between water molecules in solid ice are called ...**hydrogen**... bonds
45. The bonds between carbon dioxide molecules in solid “dry” ice are called**van der Waal**.... bonds
46. List an example of **non-polar** molecular solid .**CO₂ (s)(dry ice)** , **3-dimensional network** solid **diamond /quartz**..
47. a) this solid type is a good conductor, deformable & a mid MP.....**metal**..
b) this solid type is a poor conductor, brittle & a high MP**ionic solid**...
48. The gas phase rx $\text{HCl} + \text{Br} \rightarrow \text{Cl} + \text{HBr}$ is **endothermic**, this implies that the H-Cl bond is(**stronger**) than the H-Br bond.
49. The temperature of a substance is related to the average **kinetic energy**.. of that chemical substance.
50. Charles’ Law taught us to measure our temperatures in **kelvins**.. , 0° C = **273 K**, 25° C = **295 K**
51. The..**gas**.. phase has neither a definite volume nor a definite shape.
52. The universal gas constant, R, has a value of **8.314**.. and used in the equation. **PV = nRT**..
53. Avogadro’s Hypothesis=**equal volumes of a gas @ the same temp & pressure contain the same # of molecules**
54. a) What is the STP volume of 6.0×10^{21} molecules of hydrogen gas**0.224 L** ..
b) What is the volume of 8 g of hydrogen gas at -20° C and 1200 kPa **7.0 L (use PV = nRT)**.
55. a) What is the mass of 6.0×10^{21} molecules of neon gas**0.20 g**....
b) What mass of neon gas is in a 160 L sign if at 10° C the pressure is 3 kPa **4.08 g (use PV = nRT)**..
56. Living cells contain.....**catalysts**.... called enzymes.
57. a) Hydrogen peroxide decomposes quickly when a..**catalyst**.. like ...**MnO₂**...is added to it
b) When potassium chlorate is heated with a catalyst ...**oxygen**.. gas is produced
58. a) when metals react with oxygen gas they produce ..**oxides**... in a process called ..**oxidation**..
b) Metal oxides react with water to produce **bases**. non-metal oxides produce ...**acids**..
59. Oxidation to a chemist means ...**a loss of electrons**..
60. When $\text{C}_{16}\text{H}_{26}\text{S}_2\text{N}_2$ burns **CO₂ + H₂O + SO₃ + NO₂** are produced
61. Which group on the P.T. react most vigourously with water **group I - the alkali metals**.
62. a) When the metals react with acids **hydrogen**.. gas is produced. The H^+ was **reduced**.. to H_2
b).What test is used to identify hydrogen gas **the flaming splint test - producing a loud “pop”**
63. Where are the most reactive metals on the PT? **on the left side** why ? **have the fewest & loosest valence electrons**
64. Give an example of a metal that does not oxidize in the presence of an acid.**copper / silver / gold**.
65. What must the pH be for an ammonium compound to decompose into ammonia gas **>7 (a base)**..
66. Chemists rely on **catalysts or heat or improved surface area**..to persuade slow rxns to work

67. A reaction that involves mixing 2 salt solutions together is called **a double displacement rx**

68. When carbonates react with acids **carbon dioxide** gas is produced

69. The reactant that is completely used up in a chemical reaction is the **limiting reactant** & then the rx **stops**..

70. If 4.15 mol of oxygen react with 5.65 mol of aluminum, the limiting reagent is **oxygen**..



71. If 5.2 g of ammonia reacts with 4.6 g of oxygen to produce nitrogen gas & water, the limiting reagent is **oxygen**.



72. An unknown element is a colourless gas. Upon heating with sodium no rx occurs. The family of elements this element belongs to is called **group VIII - the inert gases**

73. When an acid is reacted with a base what type of compound is formed **water & a salt**

74. What is the pH of a sol'n which has a hydrogen ion concentration = 4.0×10^{-8} ... **7.4 (take the neg log of the number)**

75. Experimentally determining the concentration of an unknown sol'n by comparing it to the conc'n of a known standard sol'n is called **a titration**

76. Which laboratory apparatus measures volume most accurately **pipet/buret**; least accurately **beakers & flasks**.

77. 10.0 g of sodium hydroxide are dissolved in 250 mL of water, what is the [NaOH] ? **1.0 M**

$$[NaOH] = m / mm / \#L = 10g / 40g/mol / 0.250 L = 1.0 M.$$

78. What mass of potassium hydroxide is required to make 500 mL of 0.4 M sol'n ?... **11.2 g**

$$mass = [KOH] \times mm \times \#L = 0.4 M \times 56 \times 0.500 L = 11.2 g.$$

79. 23.3 g of magnesium nitrite is dissolved in 800 mL of water, what is the [nitrite ions] ?... **0.50 M**

$$[Mg(NO_2)_2] = m / mm / \#L = 23.3g / 116g/mol / 0.800 L = 0.25 M$$

$$[NO_2^-] = 2 \times [Mg(NO_2)_2] = 0.25M \times 2 = 0.50 M.$$

80. How many grams of sodium hydroxide would be required to neutralize 189 g of acetic acid ? **126 g**

$$\# \text{ moles NaOH} = \# \text{ moles acetic acid (at neutral point)}$$

$$mass NaOH / 40 g/mol = 189 g / 60 g/mol,$$

$$mass = 40 \times 189 / 60 = 126 g$$

81. A solution with BromThymol Blue in it is yellow; the pH must be \rightarrow **< 7 - acidic**.

82. What volume of 18 M stock H_2SO_4 is required to make 2 L of 0.8 M H_2SO_4 **88.8 mL**

$$volume = [diluted stock] \times vol(dil stock) / [stock] = 0.8 M \times 2 L / 18 M = 88.8 mL$$

83. 300 mL of water are added to 500 mL of 1.6 M $Ca(NO_3)_2$. What is the $[Ca^{2+}]$? ... **1.0 M**... $[NO_3^-]$... **2.0 M**...

$$[diluted Ca(NO_3)_2] = [stock] \times vol(stock) / vol(dil stock)$$

$$= 1.6 M \times 500 mL / 800 mL = 1.0 M$$

84. Write the 4 equations of **$n = mass / m$** mass **$n = PV/RT$** , **$n = \# / 6 \times 10^{23}$** , **$n = [] \times \# L$**

85. 6 g of 2,2-dimethylpropane are burned under 400 mL of water initially @ 20°C. The water temp rose to 46°C. Write the thermochemical equation for this reaction.

$$Q = mc\Delta T = 0.400 kg \times 4.184 \times 26K = 43.5 kJ, \text{ heat(comb)} = 43.5 kJ / (6g/72g/mol) = 522 kJ$$



1. Calculate the % sulfur in sodium thiosulfate pentahydrate ($\text{Na}_2\text{S}_2\text{O}_3 \cdot 5\text{H}_2\text{O}$)

$$\begin{aligned}\% \text{ S} &= \text{mass of Sulfur} / \text{formula mass} * 100 \\ &= 2 \times 32 / 248 * 100 \\ &= \mathbf{25.8 \%}\end{aligned}$$

2. A 3.32 g sample of terephthalic acid is analyzed and found to contain 1.92 g of carbon, 0.12 g of hydrogen and the rest oxygen.

a) calculate the %C, %H & %O in this compound

$$\% \text{ C} = 1.92 / 3.32 = 57.8\% \quad \% \text{ H} = 0.12 \text{ g} / 3.32 \text{ g} = 3.6\% \quad \% \text{ O} = 1.28 \text{ g} / 3.32 \text{ g} = 38.6\%$$

b) Calculate the simplest formula of terephthalic acid

$$\text{C} = 57.8\% / 12 \text{ u} = 4.8 \quad \text{H} = 3.6\% / 1 \text{ u} = 3.6 \quad \text{O} = 38.6\% / 16 = 2.4$$

$$\text{C/H ratio} = 4.8 / 3.6 = 1.33 : 1 \text{ or } 4 : 3 \quad \text{C/O ratio} = 4.8 / 2.4 = 2 : 1$$

$$\text{simplest formula} = \mathbf{C_4H_3O_2} \text{ (formula mass} = 88 \text{ g)}$$

c) A titration was done to find the molar mass of this acid. 16.6 g of the acid were exactly neutralized by 200 mL of a 0.5 M NaOH sol'n. Calculate the molar mass of terephthalic acid and thence the actual molecular formula of terephthalic acid

moles terephthalic acid = # moles NaOH (at neutral point)

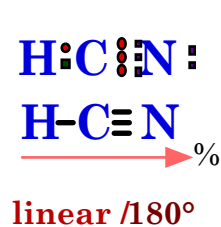
$$16.6 \text{ g} / \text{molar mass} = 0.5 \text{ M} \times 0.200 \text{ L}$$

$$\text{molar mass} = 166 \text{ g which is double the formula mass above}$$

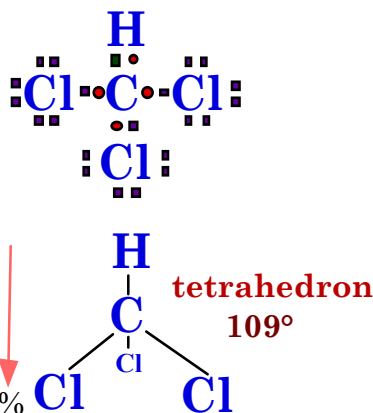
soooo the correct formula for terephthalic acid is $\mathbf{C_8H_6O_4}$ (molar mass = 166 g)

3. For each molecule, draw the Lewis dot diag, structural formula, shape, bond angles & polarity

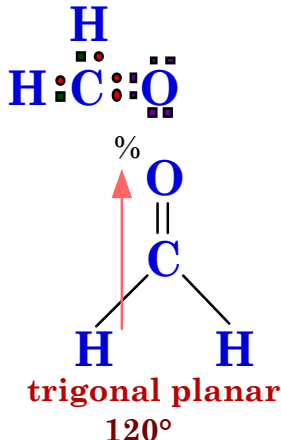
a) HCN



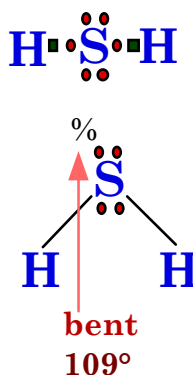
b) CHCl₃



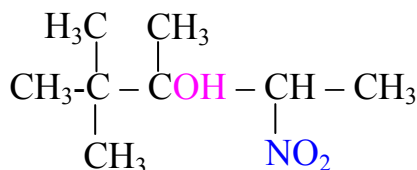
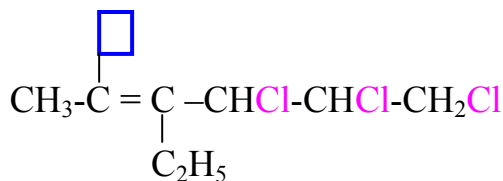
c) HCHO



d) H₂S



- b) Draw i) 4,5,6-trichloro-trans-2-cyclobutyl-3-ethyl-2-hexene ii) 4-nitro-2,2,3-trimethyl-3-pentanol



4. 29.5 g of an unknown gas at 960 kPa and 40° C was found to occupy a volume of 400 mL. Find the molar mass of this gas. This gas is a brominated hydrocarbon with 3 carbon atoms – sketch this gas and attempt to name it

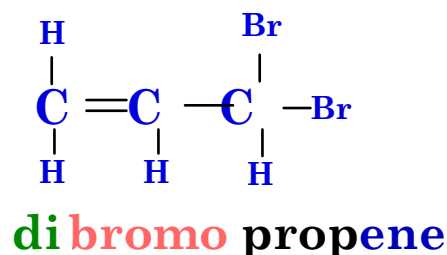
$$\text{PV} = m / \text{mm} \text{ RT or}$$

$$\text{mm} = m \text{ RT} / \text{PV}$$

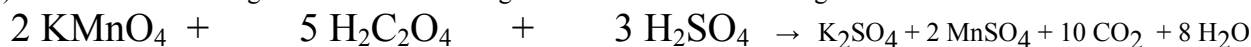
$$\text{mm} = 29.5 * 8.314 * 313 \text{ K} / (960 * 0.400 \text{ L})$$

$$= \mathbf{200 \text{ g}}$$

$$= \mathbf{C_3H_4Br_2} \text{ (g) mm is } 199.8 \text{ g/mol}$$



5 a) Determine the limiting reactant based on the given masses for the following reaction



i) **1 mole** **2.5 moles** **1.5 moles**
100g/158 **100/90** **excess**
0.633 moles **1.11 moles**
limiting (need 0.633 x 2.5 = 1.58 moles → only have 1.11 moles)

ii) **1 mole** **2.5 moles** **1.5 moles**
40g/158 **70/90** **35 / 98**
0.253 moles **0.777 moles** **0.39 moles**
limiting **have > 0.253 x 2.5** **have > 0.253 x 1.5**
= 0.6325 moles **= 0.38 moles**

b) A **100 g** chunk of magnesium is reacted with **58 L** of O_2 gas @ **25° C** & **100 kPa**. Calculate the mass of product that should be produced.

If **152 g** of product actually was produced, what is the **% yield** for this experiment?

Mg + **1/2 O₂** → **MgO**
1 mol **1/2 mol** **1 mol**
n = 100/24.3 **n = 100kPa*58 L / R*298K L**
n = 4.11 **n = 2.34*** **4.11 mol will be prod (Mg/MgO=1:1ratio)**
(*in excess-) **X = 4.11 * 40 g/mol**
only 2.05 moles required **= 164.4 of product should form**
% yield = 152 g / 164.4 * 100
= 92.5 %

6. **16 g** of calcium bicarbonate are reacted with excess **HCl**, what volume of CO_2 gas @ **23° C** & **90 kPa** is produced?

Ca(HCO₃)₂ + **2 HCl** → **CaCl₂** + **2 CO₂** + **2 H₂O**
1 mol **2 mol**
162 g **v = 2* 8.314*296 / 90 = 54.7 L**
16 g **X L**
X = 5.4 L of CO₂ gas produced

7. **10.7 g** of NH_4Cl are reacted with excess Ca(OH)_2 what volume of NH_3 gas @ **26° C** & **98.4 kPa** is produced?

2 NH₄Cl + **Ca(OH)₂** → **2 NH₃** + **2 H₂O** + **CaCl₂**
2 mol **2 mol**
53.5 g **v = 1* 8.314 * 299 / 98.4 = 25.26 L**
10.7 g **X L**
X = 5.05 L of NH₃ gas produced

8. A sample of magnesium sulfate **hydrate** with a mass of **2.465 g** was heated to produce **1.204 g** of the anhydrous salt magnesium sulfate. Determine the formula of this hydrated salt (ie the value of **X**)

mass of MgSO₄ .xH₂O = 2.465 g
mass of MgSO₄ (dry) = 1.204 g **mass of water = 1.261 g**
n(MgSO₄) = 1.204/120 = 0.01 moles **n (water) = 1.261 g/ 18g = 0.07 moles**
x = n (water) / n(MgSO₄)
= 0.07 / 0.01
= 7 **→→→ formula = MgSO₄ .7H₂O**

9. **3.8 g** of **impure** stock **NaOH** are dissolved in **250 mL** of distilled water.

****20 mL** samples of this **base** were **titrated** against **0.15 M HNO₃** and the following data were collected and recorded :

	<u>Rough titration</u>	<u>Titration #1</u>	<u>Titration #2</u>
initial buret reading	1.6 mL	4.8 mL	0.4 mL
final buret reading	24.5 mL	27.2 mL	22.8 mL

A) From the **titration data**** calculate the "true" **concentration** of the NaOH sol'n **then**

B) Calculate the **mass** of **pure** NaOH that must have been in the sample **then**

C) Calculate the **% purity** of this impure NaOH reagent

$$\# \text{ moles HNO}_3 = \# \text{ moles NaOH (at neutral point)}$$

$$0.15 \text{ M} \times 0.0224 \text{ L} = [\text{NaOH}] \times 0.020 \text{ L}$$

$$[\text{NaOH}] = 0.168 \text{ M}$$

$$\text{mass NaOH} = 0.168 \text{ M} \times 40 \times 0.250 \text{ L}$$

$$= 1.68 \text{ g}$$

$$\% \text{ purity} = \text{calculated mass} / \text{measured mass} \times 100$$

$$= 1.68 \text{ g} / 3.8 \text{ g} \times 100$$

$$= 44.2 \%$$

10. A new compound "Longous acid" is discovered at the St.Brian Laboratories Inc. It was known to be an **oxy acid** containing one of the **halogens** (Group 7).

*i) A stock base solution was made by dissolving **4.0 g of NaOH** in **500 mL of water**.

ii) A solution of the acid was made by dissolving **4.1 g** of acid in **250 mL of H₂O**.

****iii) SOME** of this **acidic solution** (**25 mL**) was titrated against the base (NaOH) producing the following results:

<u>Rough titration</u>	<u>Titration #1</u>	<u>Titration #2</u>
initial buret reading	0.10 mL base	20.10 mL
final buret reading	20.10 mL	34.56 mL

A) From the **data*** calculate the **concentration** of the base solution you made.

B) Using the **titration data**** calculate the **concentration** of the unknown acid sol'n then the **molar mass** of the acid and then **identify** Longous acid by **name & formula**.

$$\text{A)} \quad [\text{NaOH}] = 4.0 \text{ g} / 40 \text{ g} / 0.500 \text{ L} = 0.2 \text{ M}$$

$$\text{B)} \quad \# \text{ moles "acid"} = \# \text{ moles NaOH (at neutral point)}$$

$$[\text{acid}] \times 0.025 \text{ L} = 0.2 \text{ M} \times 0.018115 \text{ L}$$

$$[\text{acid}] = 0.14492$$

$$\text{C)} \quad \text{molar mass} = \text{mass} / ([\text{acid}] \times \text{vol acid made})$$

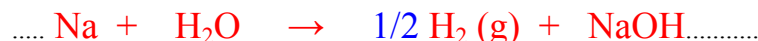
$$= 4.1 \text{ g} / 0.14492 \times 0.250$$

$$= 113 \text{ g}$$

$$\text{D)} \quad \text{acid could be HBrO}_2 \quad \text{mm} = 113 \text{ (contains a halogen, is an oxy acid)}$$

11. Complete & balance the following reaction equations

A) A chunk of **sodium** is dropped into a cup of **water**.



B) Some **C₉H₁₈N₂S** is **burned** in excess **oxygen**.



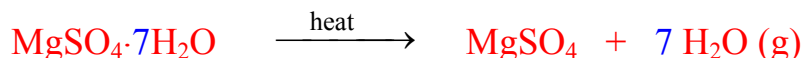
C) Some **pentene** is **burned** in reduced **oxygen**.



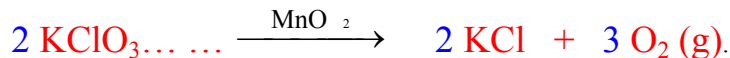
D) A solution of **ammonium phosphate** is added to a solution of **copper(II) sulfate**.



E) A hydrated salt, **magnesium sulfate heptahydrate**, is heated vigorously over a burner.



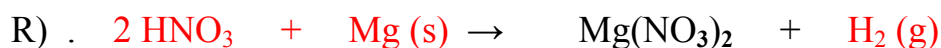
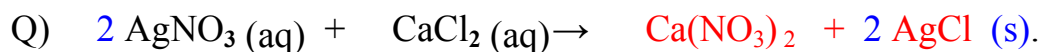
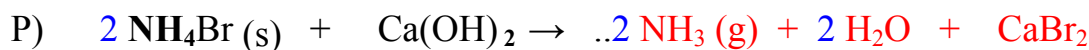
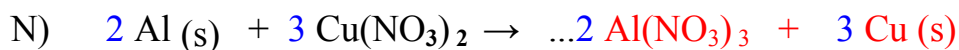
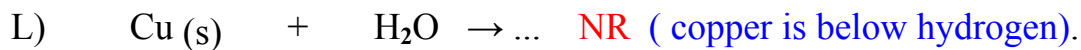
F) **potassium chlorate** is heated in the presence of a small quantity of manganese dioxide (MnO_2)



G) A solution of **platinum(III) nitrate** is stirred with a **zinc**-plated spoon.



H) A piece of **magnesium** is left overnight in a solution of **acetic acid**



be sure Q,R&S
are different reaction types

